

Collaboration, Alignment and Leadership

David W. Fulker

Unidata Director Emeritus

University Corporation for Atmospheric Research

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Introduction

This essay compares and contrasts—from my personal perspective—four projects funded by the National Science Foundation (NSF) that have depended critically upon medium- to large-scale collaboration. This characteristic distinguishes them from most NSF-funded projects, as typified by the Program Officer for one of the four: *“The NSDL program is an unusual program for NSF in that its projects are engaged in building an enterprise much larger than the object of any one grant. Indeed, the success of the program rests squarely on the extent to which the many projects can embrace this collective sense of identity and mission.”* [Zia 2001]. Though similarly reliant on collaboration, the four projects had significantly different outcomes, and the purpose of comparison is to consider why, with particular emphasis on matters of leadership.

Four Highly Collaborative Projects

The NSF’s research and education portfolio includes many goals and objectives that can be achieved only through collaboration. This requirement can arise from joining multiple disciplines or from matters of scope and scale, as shown by four examples spanning nearly three decades (with dates approximately as indicated, ignoring their incubation phases).

- NSFNET (1984-1995) – NSF’s goal of a single internet, built on lessons learned with ARPANET, BITNET, CSNET and others, but yielding interoperable connectivity across all of academia (and, eventually, the entire non-academic world) [Leiner et al., 2000], required an extraordinary level of collaboration across:
 - Geographic regions as well as institutional and political boundaries.
 - Engineering and research, to create reliable infrastructure from innovation.
 - Established networks on which many constituents already were relying.
 - Public and private institutions, building commerce upon research results.
- Unidata (1983-Present) – In funding Unidata, the goal of the Atmospheric Sciences Division (ATM) was to help universities employ computing and communication technologies to access, display and analyze scientific data [Sherretz & Fulker 1988]. Envisaged as a merging of systems from several universities, this entailed modest collaboration from the outset, but Unidata evolved to be so participatory that it eventually was described as a “collaboratory” [Fulker et al., 1997] and cited as a “virtual community” [Rodrigues et al., 2004]. This required collaboration among or across:
 - Institutional boundaries and large distances.
 - Engineering and research, to create reliable systems from university prototypes.
 - Builders of (incompatible) systems, on which constituents already were relying.

- Researchers and educators, whose data interests are similar but distinct.
- DLESE (1999-2006) – The Geosciences Directorate (NSF/GEO), with assistance from NASA, embraced an ambitious agenda when it established the Digital Library for Earth System Education (DLESE): “... *a program plan and structure for the establishment of a national digital library that promises to have a profound impact on geoscience education at all levels. ... It will also provide an important vehicle for facilitating the implementation of the Earth and Space Science component of the National Science Education Standards.*” [Mayhew 1999] This required collaboration among or across:
 - Institutional boundaries and large distances.
 - Engineering and research, to build reliable systems from prior research work.
 - Geoscience disciplines that, in some cases, had minimal common history.
 - Geoscience researchers, educational researchers and educators.
- NSDL (2000-Present) – The goal of the Education and Human Resources Directorate (NSF/EHR) in forming and funding NSDL was similar to that for DLESE¹ except for its larger scope: “*The resulting virtual institution is expected to catalyze and support continual improvements in the quality of science, mathematics, engineering, and technology (SMET) education in both formal and informal settings.*” [Zia 2001]. Also similar to DLESE, but more explicitly, expectations for NSDL were informed by digital-library research initiatives that began in the early 1990s (under the Computer and Information Science and Engineering Directorate of NSF) [NRC 1998]. The NSDL initiative required collaboration across:
 - Institutional boundaries and large distances.
 - Engineering and research, to build reliable systems from prior research work.
 - Established libraries, digital and physical, on which constituents were relying.
 - SMET disciplines that, in some cases, had minimal common history.
 - Digital-library researchers, educational researchers and educators.
 - Public and private institutions, to evolve publishing practices.

¹ Though DLESE became one of the libraries that incorporated itself into NSDL, and received NSDL funds, this author sees the two libraries as distinct. Indeed, DLESE was functioning before most of NSDL and relied upon significant independent funding (primarily from the Geosciences Directorate at NSF).

difficulties, per se, likely are symptoms of deeper issues², I attempt here to look for underlying causes, with particular attention to leadership differences among the projects.

This lens is motivated by the observation that collaboration challenges—including cases where the needs were driven by scope, scale, and multiple disciplines—have been addressed effectively in both the corporate and nonprofit worlds. My informal thesis is that the two *growing, sustained* projects (from the above list) aligned more closely than the other two with principles of *leadership excellence*, and enhanced collaboration was among the consequences³.

Pursuing this line, I examine the four examples in a framework of leadership principles that I have selected because they appear directly related to the collaborative aspects of successful organizations. The chosen principles—drawn from writings by Jim Collins in *Good to Great* and by Michael Treacy and Fred Wiersema in the *Harvard Business Review*—are as follows.

- **Disciplined Thought** [Collins 2001 pp 65-119]
 - *Willingness to confront reality*
 - *A simple, coherent strategic concept*
- **Disciplined Action** [Collins 2001 pp 123-143]
 - *Willingness to say “no”*
 - *Clear identification of who holds responsibilities*
 - *Advancement as a cumulative process*
- **Persistent Core** [Collins, pp 188-201]
 - *An enduring purpose*
 - *Immutable core values (around which to advance)*
- **Primary alignment with one of three value disciplines (while attending to the other two)** [Treacy & Wiersema 1993]
 - *Operational Excellence*
 - *Customer Relations*
 - *Product Leadership*

Assessing Projects in Relation to the Leadership Framework

Rough project comparisons, along the principles of the framework, are set forth in the following paragraphs.

Willingness to confront reality – Though all four of the projects cited here faced major challenges of scope, NSDL and DLESE seemed less able than the others to gain agreement on how to limit expectations during startup. Furthermore, NSDL and DLESE—both tied to the “library” legacy—were immediately embroiled the problems of purpose and identity brought

² E.g., James Austin offers “Seven C’s of Constructive Collaboration”—Clarity, Complementarity, Compatibility, Communication, Creativity, Commitment, Courage—and implies that their absence yields ineffective alliances [Austin 1998]. These of course might serve as a reasonable framework for collaboration analysis, and they reinforce some aspects of the framework I have chosen.

³ In the spirit of disclosure, I played leadership roles in three of the four projects. Specifically, I was a principal investigator and founding director for Unidata; I served on the steering committee for DLESE and was a co-principal investigator on grants for the DLESE Program Center; finally, I was a principal investigator and the first Executive Director for the NSDL Core Integration Team until 2005.

upon every library by the realities of Internet, Google and other disruptive technologies⁴. Absent such legacies, and with somewhat operationally oriented leadership (at NSF, on steering committees, etc.), NSFNET and Unidata had more latitude for confronting the realities that startups must face, especially the reality that pleasing every collaborator and constituent is literally impossible.

A simple, coherent strategic concept (Collins' "hedgehog concept"⁵) – At least in hindsight, the four cited projects might be ranked for simplicity of concept (from simple to complex) as follows: NSFNET, Unidata, DLESE and NSDL. In the first two cases, I think simplicity was encouraged by NSF's grant structure, whereas the grant structures for NSDL and DLESE tended to favor diversity over coherence. This led to imprecise alignments among the collaborators' visions and priorities, which in turn compounded the difficulties DLESE and NSDL had in gaining collaborator agreement on value propositions and target constituents.

Foreshadowing of this difficulty in NSDL may be discerned from the previously mentioned NRC report by comparing, for example, the following two quotes from Appendix B. Note Arm's implicit focus on "library" as (expertly selected) content in contrast with Lynch's focus on "library" as place for transformative action.

- *"All materials in the library will be selected by members of the library staff. Sometimes, selection will be at an item level, at other times by groups of material. The method of selection and the selection criteria will be stored with all material, so that users will know why each item is in the library."* [NRC/Arms 1998]
- *"A library [serving] undergraduates in science, engineering, mathematics and related subjects (and their teachers) is primarily an engine for enhanced teaching and learning rather than an opportunity to transform the broad system of scholarly communication and publishing. ... In my view, much of the challenge here is how to supplement, extend, and enhance traditional textbooks and related educational materials (such as problem sets or experimental exercises) in the digital environment."* [NRC/Lynch 1998]

Willingness to say "no" – Admitting that this is highly subjective, I think the NSF structuring of the NSFNET and Unidata grant programs provided better cover and support for leadership decisions about what not to do, in comparison with how DLESE and NSDL were shaped. In the NSFNET case, one might cite the decision not to support (at least initially) certain protocols (such as BITNET, SNA and X.25), even though they were currently in use or represented international standards. In Unidata, a number of (controversial) decisions were made about which data-visualization and -analysis packages could or could not be fully supported. In contrast, I think both digital libraries found it hard to gain agreement and support for decisions

⁴ James Keller anticipated aspects of this problem early in the NSDL planning stage: "The ability of the digital library to recast the learning process by extending across traditionally distinct institutions and processes raises the question of whether the word 'library' remains an appropriate moniker. The so-called 'digital library' will, if properly designed, quickly become a part of most, if not all, scholarly aspects of the university and the larger research community." [NRC/Keller 1998]

⁵ Collins, in *Good to Great* (referencing an Isaiah Berlin essay, "the Hedgehog and the Fox") asserts that the most successful companies are more like hedgehogs than foxes. The latter are characterized as seeing a complex world and acting on many levels, where hedgehogs integrate their decisions and actions under a single concept or unifying vision, yielding remarkable clarity and simplicity. [Collins 2001, pp 90-120]

about focus, and this situation was exacerbated by the committee structures mentioned below as well as the absence of a clear “hedgehog” concept for each library.

Clear identification of who holds responsibilities – In a similarly subjective vein, I think that the NSF Program Officers for DLESE and NSDL felt more constrained (than those for NSFNET and Unidata) in clearly designating leadership responsibility. DLESE and NSDL also adopted committee structures that, rather than being advisory, were chartered to play roles more akin to governance, and this effectively diffused the leadership responsibilities.

Advancement as a cumulative process – Fortunately for NSFNET and Unidata, NSF support remained steady and strong through difficult, controversial times. Similar attitudes have been evident in NSDL and DLESE, but for the latter, the duration of this patience may have been insufficient. True community-wide enthusiasm for Unidata took something like a decade to achieve, and one of Unidata’s key low-level software packages (NetCDF) required some 10-15 years after its first release to achieve widespread use (in the geosciences). Personally, I was saddened by the cessation of NSF/GEO funding for DLESE at a point when evidence of educator enthusiasm was ramping up and important ideas were beginning to emerge on such important topics as:

- Fostering and supporting educationally and scientifically effective uses of numeric data (i.e., key concepts for extending the traditional notion of library content).
- Creatively linking library resources to educational standards and sophisticated characterizations of learners’ conceptual development. [Butcher et al., 2006]
- Modeling the library less as a place for finding and accessing content and more as a place for development along the lines envisaged by Lynch (as quoted above).
- Building community among (sometimes isolated) science educators.

An enduring purpose – As mentioned earlier, the term “library” has been a mixed blessing for DLESE and NSDL. On the one hand, it evokes a history and legacy that is nothing if not enduring. On the other hand, clear statements of purpose for digital libraries such as NSDL and DLESE have been devilishly difficult to articulate, much less to adopt in collaborative settings, because Google and similar technologies have so disrupted the traditional approaches to finding and accessing information [Lagoze et al., 2005]. Fortunately for Unidata and NSFNET, their original purposes—simple as they were—withstanding the test of time.

Immutable core values (around which to advance) – Perhaps this item should not be in the analysis framework, because I perceive little variation among the examples. Each of the four programs was built around core values shared by all stakeholders, including the NSF Program Officers and the key collaborators. The only exception may have been conflicting views in DLESE about the place of traditional peer review in collection building. For some, this value was so central that its absence would fundamentally diminish the value of DLESE. For others, emerging possibilities for materials evaluation (employing technology-enabled networks of trust, feedback from teachers and learners, well constructed usage statistics, etc.) held such promise in

terms of scalability and end-user engagement that traditional peer review (especially as a library function rather than a publisher function) seemed contrary to educational advancement⁶.

Primary alignment with a single value discipline (among operational excellence, customer relations, and product leadership) – NSF’s rather prescriptive grant program for NSFNET was aligned primarily with operational excellence, capitalizing on the relative maturity of TCP/IP. Unidata’s earliest focus was on customer relations, and the alignment successfully shifted toward product leadership (i.e., leading-edge software tools) during the 1990s. In contrast, I think community leaders and NSF all contributed to NSDL and DLESE ambiguity regarding value proposition and value discipline. In making this judgment, I note that none of the value disciplines is easy to achieve without clarity about concept, purpose and target constituents, reflected in the other elements of this framework. For example, returning to the quotations cited above, Arms’ perspective seems to lead toward operational excellence, while Lynch’s seems to imply product leadership.

Subjective Conclusion

The foregoing analysis, though neither objective nor particularly rigorous, leads me to conclude that the variability in program outcomes is indeed *related to the degree of project alignment with key leadership principles*. In particular, I think that the two *growing/sustained* endeavors, namely NSFNET and Unidata, aligned more closely than the other two⁷ with specific principles of leadership excellence put forth by Collins, Treacy and Wiersema. This suggests that NSF might wish to evaluate such alignment as a part of designing projects where collaboration is critical.

If NSF takes this step, I recommend gaining the assistance of experts like Collins, Treacy and Wiersema in developing an evaluation framework that is tighter than the one I have employed, eliminating redundancies and explaining the principles in terms specifically matched to proposal evaluation rather than the informal, reflective mode of my analysis.

Personal Musings on a Successful NSDL

The NSF’s early digital-library research initiatives [Larsen & Wactlar 2003] yielded very promising results regarding discipline-specific content and/or presentation, as well as generic library functionality (especially various forms of search), but left unanswered, in my view, the following three questions:

⁶ Though written in the context of NSDL planning, Keller’s previously cited contribution to the NRC report anticipates this tension: “*Technical development of the key functional elements of a national digital library to support undergraduate SMET education can largely be fulfilled with existing web-capabilities. It can be built with existing knowledge and tools, but successful use of this resource will require a fundamental rethinking of the larger learning process in which it is intended to operate. This would affect some of the defining elements of the university, including peer review, standards for professional achievement, and undergraduate teaching.*” [NRC/Keller 1998]

⁷ I recognize that comparing the outcomes of NSDL with those of the much older NSFNET and Unidata projects may be premature. Nonetheless, at comparable ages, I think NSFNET and Unidata exhibited greater evidence of agreement about the natures of the attendant collaborations, especially in relation to the central facilities. To the extent that my thesis is correct—i.e., that this lack of agreement is related to leadership shortfalls—then I certainly share culpability.

1. What capabilities—available in digital libraries, either now or in the future—will be *fundamentally* important for large-scale enhancement of teaching and learning?
2. To the extent that these key capabilities *can and should be common across (all STEM⁸-related?) digital libraries*, how best can such commonality be supported?
3. What is the best means for digital libraries, where primary emphasis often has been on Internet-wide accessibility, to build enduring relationships with end users?

I think we neglected these questions early in the NSDL effort so as to implement (utilizing OAI, the Open Archives Initiative) a quick solution to the perceived need for basic interoperability. To some degree, we assumed that the answers would emerge as the NSDL became functional and reflected the varied strengths of its component libraries. In hindsight (and I do not mean to discount NSDL's OAI achievements) I believe it would have been more effective to approach interoperability with a deeper understanding of the need for it *in the educational context implied by questions 1 and 2*. Doing so, even if it delayed the initial “release” of NSDL, might have engendered higher levels of cooperation among the NSDL grantees and, more important, might have actually accelerated NSDL use by educators.

A related factor was that my Unidata experience led me to emphasize the role of “community” in the Core Integration effort for NSDL. In retrospect, I did not recognize that: despite significant agreement on the *general* need for a digital library focused on STEM-education—similar to the kind of agreement that existed among meteorology departments about the need for Unidata in 1983—lack of agreement on *specific* needs, and the means for meeting them (as might have grown from answers to the three questions), made community-building difficult (more so than in Unidata) and perhaps premature.

Exacerbating this problem was the fact that “community” in Unidata corresponded rather closely to “users,” whereas the basic plan for NSDL construction placed more developers than users at the community table. (This is the primary reason I articulate question three.) Businesses occasionally succeed under the “build it and they will come” model, but a strong focus on end-user needs is typically required earlier than later.

Looking to the future, I suspect that answers to the three questions posed above are within reach. Of course one possible answer to the second question is simply that minimal commonality is required, and that NSF generally should support discipline- and age-specific specialization as the primary keys to educational enhancement. However, I believe that the most educationally transformative digital libraries are likely to have a great deal in common, basing my view on indications of progress such as the following:

- The integration of AAAS “Strand Maps” into DLESE [Sumner et al., 2005]—and subsequently into NSDL—sets the stage for new forms of educational library use, where best practices in science learning help shape users’ experiences of browsing and resource aggregation.
- The replacement of the NSDL “union catalog,” which comprised proxies for individual library resources, with an RDF based system that supports characterization of *relations among resources*, sets the stage for digital libraries that foster understanding about the highly constructive nature of learning and of knowledge creation.

⁸ STEM is an acronym for science, technology, engineering and mathematics.

Restating the above, I envision an NSDL that fosters meta-cognition about learning. Libraries have always been places for knowledge *construction* (think about a student's or a researcher's personal collections of 3x5 cards, for example), where one's mental model is transformed not merely by the absorption of ideas from individual resources, but also by awareness of the contrasts and similarities *among* such resources, augmented by one's own notes. In the spirit of the recent OAI-ORE specification [Lagoze et al., 2008], such meta-cognition might well be modeled and encouraged via "aggregations." Indeed, educational constructivism might serve as the basis for an NSDL "hedgehog" concept.

I feel certain that suitable infrastructure—extending NSDL's central core, such as by embedding capabilities to exploit the ORE standard—will be crucial for realizing this transformative power on large scales, especially if it can be realized in ways that truly complement and utilize the strengths of legacy libraries at the nation's educational institutions (where strong end-user connections already exist). There are examples of such complementarity at the level of component NSDL libraries, so NSDL writ large may be positioned to capitalize on the pattern, though modification may be required in the K-12 arena.

Finally, I have confidence in present NSDL leaders, and I hope they find this essay constructive. Two of the leadership traits I have highlighted (disciplined thought and disciplined action) are in greater evidence than when I was involved. Further, I think that even partial answers to the three questions posed above may help NSDL gain the focus implied by the other two leadership traits (a persistent core and primary alignment with one of three value disciplines). Underlying my optimism is the hope that the NSF will remain a supportive and patient sponsor, recognizing that major collaborative efforts necessarily travel rough roads in their early stages.

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